Stream Fishes Estimate Water Quality in Dayton-Montgomery County Park District Reserves[1]

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ABSTRACT. **Information on fish communities within seven streams and rivers in or near Dayton-Montgomery County Park District reserves was collected and analyzed to compile a preliminary species list for Park District waters and to estimate water quality of the streams. Fifty-two species of fishes were found in lotic habitats in or near the reserves, and more extensive sampling likely will reveal the presence of additional species. Index of Biotic Integrity (IBI) scoring of the fish communities indicated that water quality within the reserves ranged from fair to exceptional. It would appear that improvements of water quality and fish communities within the reserves may require changes in wastewater treatment outfalls and stream drainage land-use practices.**

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INTRODUCTION

The Dayton-Montgomery County Park District is comprised of eight nature reserves encompassing 2590 ha of upland habitat and a variety of ponds, lakes, and streams. The reserves serve as hosts to over three million visitors each year. Fishing, boating, hiking, picnicking, camping, skiing, and educational programs are a few of the activities available to visitors at the reserves.

Streams and rivers flow within the boundaries of most of the reserves, supporting a wide diversity of fish species and many angling opportunities. Personnel from the Ohio Department of Natural Resources (ODNR) and the Ohio Environmental Protection Agency (EPA) have collected information concerning the fish communities in the larger rivers (the Great Miami, Stillwater, and Mad Rivers) that flow through several of the reserves (Ohio EPA 1987; D. Nolin, Dayton-Montgomery County Park District pers. comm.), but few data are available describing fish communities in the smaller streams. The objectives of the present study were: 1) to gather information about the fish communities inhabiting four of the smaller streams within the reserves; 2) to use this information in conjunction with data about fish in the larger rivers to compile a fish species list for the Park District reserves; and 3) to calculate an Index of Biotic Integrity (IBI) (Karr 1981) based on the fish communities in each stream as an estimate of water quality.

MATERIALS AND METHODS

The fish communities in four small streams (Twin Creek in Germantown Reserve, Dry Lick Run in Carriage Hill Reserve, Sugar Creek in Sugarcreek Reserve, Opossum Creek in Possum Creek Reserve) (Fig. 1) were surveyed in October and November 1988. All streams except Sugar Creek (Little Miami River drainage) are part of the Great Miami River drainage. A representative, 150-m section of each stream was selected and fish within each section were collected with a backpack electrofisher (Smith-Root Type VII). Fish were held in 120-l containers filled with stream water until the entire stream section had been surveyed. They were then identified, counted, examined for the presence of deformities, eroded fins, lesions, and tumors (DELT anomalies), and returned to the stream unharmed.

Data on fish communities in large rivers of the Great Miami River drainage (Great Miami River in Taylorsville Reserve, Stillwater River in Englewood Reserve, Mad River in Huffman Reserve) (Fig. 1) were obtained from the Ohio EPA. Collections on these rivers were made by Ohio EPA personnel between 1980 and 1988. The Mad River collection was made within reserve boundaries and was used without modification. Collections on the Great Miami River and the Stillwater River, however, were not made within the reserves. To estimate fish communities within the reserve sections of these two rivers, both the nearest upstream and downstream collections (generally within 2.5 km of the reserves) were analyzed.

Fish community data were used to estimate water quality in each stream using the 12 metrics of the IBI (Karr 1981), as modified for Ohio waters by the Ohio EPA (1987). To facilitate calculation of the IBI for each system, drainage areas above each collection site were determined with the aid of topographic maps and a digital planimeter (Fig. 1). Because data obtained from the Ohio EPA did not contain information on the numbers of fish with DELT anomalies, the three river sites arbitrarily were assigned an intermediate value of 3 for this metric. Interpretation of the index calculated for each site was based on a comparison to streams in the Eastern Corn Belt Plains Ecoregion of Ohio (Ohio EPA 1987, Whittier et al. 1987). Several diversity measures also were calculated for each fish community (Zar 1974, Begon et al. 1986) and compared to the IBI using simple correlation (Zar 1974).

RESULTS AND DISCUSSION

Fifty species of fish were found in lotic systems in or near the Park District reserves (Table 1). Of this total, 10

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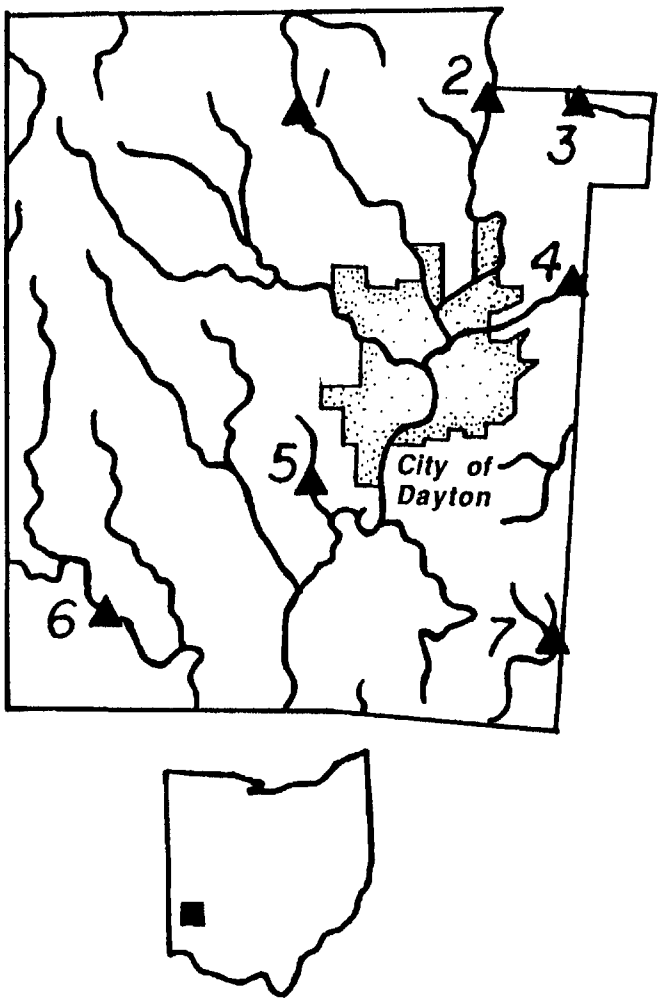

FIGURE 1. Location of Dayton-Montgomery County Park District reserves on streams and rivers throughout Montgomery County. Inset shows location of the study area in southwestern Ohio. Streams and rivers within reserves, and stream/river drainage areas (km^2) above reserves are: (1) Stillwater River in Englewood Reserve (1,632); (2) Great Miami River in Taylorsville Reserve (2,966); (3) Dry Lick Run in Carriage Hill Reserve (7); (4) Mad River in Huffman Reserve (1,645); (5) Opossum Creek in Possum Creek Reserve (5); (6) Twin Creek in Germantown Reserve (712); and, (7) Sugar Creek in Sugarcreek Reserve (40).

species were found only in the smaller streams, 25 species occurred only in the rivers, and 15 species were present in both the smaller streams and the rivers. Green sunfish was the only species present at all sites, whereas white suckers, creek chubs, and bluntnose minnows were each found at all but one location. Creek chubs and central stonerollers tended to dominate collections in the smaller streams, whereas common carp, golden redhorse, and green sunfish were the most abundant species at the river sites. Sixteen species were collected at only one of the seven locations.

In addition to those species documented by this study, occasional collections of stream fishes in the reserves by various individuals and groups have included several additional species (D. Nolin pers. comm.). The validity of most of these identifications is questionable, considering the absence of taxonomic expertise among the collectors and the unavailability of voucher specimens. However, two species, brook stickleback (*Culaea inconstans*) and fathead minnow (*Pimephales promelas*), have appeared on collection lists from Dry Lick Run; and, their presence has been documented by trained fishery biologists in a section of the reserve stream not sampled in the present study (D. Nolin pers. comm.).

Trautman (1981) lists 67 species of fish known to occur in Montgomery County. The 52 species collected in streams and rivers in or near Dayton-Montgomery County Park District reserves by the present and previous studies indicate that reserve waters contain the majority of the species present in the county. Undoubtedly, more extensive sampling of reserve streams and rivers will reveal the presence of additional species of fish, especially the rarer forms. Given the diversity of lotic habitats within the Park District reserves, it appears likely that nearly all species of stream fishes present in Montgomery County could be found within the boundaries of the reserves.

The diversity indices indicated that Twin Creek had the most diverse fish community, followed by the three rivers and then the three smaller streams (Table 2). Opossum Creek had the lowest diversity of the sites examined. Diversity indices such as these are sensitive to both numbers of species and evenness of distribution among species (Zar 1974, Begon et al. 1986). Twin Creek, with 19 total species and no single species dominating the community, received the highest diversity rating. The river sites contained more species (19-28), but usually were dominated by two or three species (see dominance values in Table 2). The small stream communities also were dominated by a few species, but the total numbers of species present were lower (8-17).

IBI scoring of the fish communities resulted in fair or good ratings for most of the sites (Table 3). Sites on the Stillwater and Great Miami Rivers, upstream and downstream from the reserves, were rated good to exceptional. Overall, the ratings of the smaller streams were reduced because they lacked the expected numbers of darter species, sensitive or intolerant species, and insectivores. River site IBIs often were lowered by relatively high percentages of tolerant species and low percentages of top carnivores. The Mad River collection also had few insectivores and a high percentage of omnivores which served to further suppress the IBI.

There was no significant relationship ($r^2 = 0.003$ and 0.03 for Simpson and Shannon diversity indices, respectively, versus IBI scores) between IBI scores and diversity indices for the various sites. IBI scoring is adjusted for differences in stream size because fewer species are expected in smaller streams, even with exceptional water quality (Karr et al. 1986, Ohio EPA 1987). No such adjustments are possible with diversity indices. Therefore, a small stream such as Opossum Creek can have few species and a low diversity but a relatively high IBI score (Fig. 1, Tables 2, 3).

In Montgomery County, water quality in warmwater streams is considered acceptable when IBI scores are 40 or higher (42 or higher in larger rivers) (Ohio EPA 1987). Only Sugar Creek in Sugarcreek Reserve and the Mad River in Huffman Reserve did not achieve this standard. The Sugar Creek site is located several kilometers downstream from the Centerville wastewater treatment plant.

TABLE 1

Numbers of fish collected in 150-meter sections of four small streams and 1-km sections of larger rivers in or near the Dayton-Montgomery County Park District reserves. Values in parentheses are percentages of the total fish collected at each site.

Species	Small Streams				Rivers		
	Twin Creek	Opossum Creek	Dry Lick Run[a]	Sugar Creek	Mad River	Stillwater River	Great Miami River
Clupeidae							
Gizzard shad					79	6-21	4-14
Dorosoma cepedianum					(24.0)	(1.4-4.0)	(0.8-2.7)
Esocidae							
Northern pike							0-1
Esox lucius							(0.0-0.1)
Cyprinidae							
Common carp					17	41-60	45-48
Cyprinus carpio					(5.2)	(7.7-13.5)	(8.9-9.4)
Goldfish						0-5	
Carassius auratus						(0.0-0.9)	
Golden shiner						2	4-53
Notemigonus crysoluecas						(0.4-0.5)	(0.8-10.3)
River chub						0-1	
Nocomis micropogon						(0.0-0.2)	
Blacknose dace		20	15	32			
Rhinichthyes atratulus		(7.4)	(7.3)	(11.4)			
Creek chub	1	48	40	95	10	0-2	
Semotilus atromaculatus	(0.7)	(17.9)	(19.5)	(34.0)	(3.0)	(0.0-0.5)	
Southern redbelly dace		2	64	1			
Phoxinus erythrogaster		(0.7)	(31.2)	(0.4)			
Silver shiner	6				21	1	0-1
Notropis photogenis	(4.3)				(6.4)	(0.2-0.3)	(0.0-0.1)
Rosyface shiner	1			6			
Notropis rubellus	(0.7)			(2.1)			
Striped shiner	3			5	1	0-1	5-10
Notropis chrysocephalus	(2.1)			(1.8)	(0.3)	(0.0-0.2)	(1.0-2.0)
Spotfin shiner	10			3	3	7-10	7-15
Notropis spilopterus	(7.1)			(1.1)	(0.9)	(1.2-2.2)	(1.4-3.0)
Sand shiner	12			1			1-4
Notropis stramineus	(8.6)			(0.4)			(0.1-0.8)
Silverjaw minnow	2						
Ericymba buccata	(1.4)						
Bluntnose minnow	11		2	18	3	3-25	1-2
Pimephales notatus	(7.9)		(1.0)	(6.4)	(0.9)	(0.6-5.6)	(0.1-0.3)
Central stoneroller	10	160	69	47	14		
Campostoma anomalum	(7.1)	(59.5)	(33.7)	(16.8)	(4.3)		
Catostomidae							
Quillback carpsucker						1-2	2-3
Carpiodes cyprinus						(0.2-0.4)	(0.3-0.5)
Highfin carpsucker							0-3
Carpiodes velifer							(0.0-0.5)
Black redhorse					1	23-25	1
Moxostoma duquesnei					(0.3)	(4.2-5.6)	(0.1)
Golden redhorse	15				1	163-193	85-245
Moxostoma erythrurum	(11.0)				(0.3)	(35.8-36.6)	(16.6-47.9)
Shorthead redhorse						6-13	0-5
Moxostoma macrolepidotum						(1.4-2.4)	(0.0-0.9)
River redhorse						4-13	
Moxostoma carinatum						(0.9-2.4)	
Northern hog sucker	4			4	34	17-71	3-25
Hypentelium nigricans	(2.9)			(1.4)	(10.3)	(3.2-15.9)	(0.7-4.9)
White sucker	3	20		50	83	1-5	7-13
Campostoma anomalum	(2.2)	(7.4)		(17.9)	(25.2)	(0.2-0.9)	(1.4-2.5)

TABLE 1 *(continued)*

Species	Small Streams				Rivers		
	Twin Creek	Opossum Creek	Dry Lick Run[a]	Sugar Creek	Mad River	Stillwater River	Great Miami River
Spotted sucker						1-2	1-19
Minytrema melanops						(0.1-0.5)	(0.1-3.8)
Ictaluridae							
Channel catfish						0-1	1
Ictalurus punctatus						(0.0-0.1)	(0.1)
Yellow bullhead							0-1
Ictalurus natalis							(0.0-0.1)
Brown bullhead					1	0-1	
Ictalurus nebulosus					(0.3)	(0.0-0.1)	
Black bullhead							0-1
Ictalurus melas							(0.0-0.1)
Percichthyidae							
White bass							0-1
Morone chrysops							(0.0-0.1)
Centrarchidae							
White crappie						1-7	0-23
Pomoxis annularis						(0.2-1.2)	(0.0-4.4)
Black crappie						0-1	1-7
Pomoxis nigromaculatus						(0.0-0.1)	(0.1-1.4)
Rock bass	8				19	5-11	9-33
Ambloplites rupestris	(5.7)				(5.8)	(1.1-2.0)	(1.7-6.5)
Smallmouth bass	9			2	19	8-16	4-12
Micropterus dolomieui	(6.4)			(0.7)	(5.8)	(1.8-3.0)	(0.8-2.3)
Largemouth bass					4	5-19	0-4
Micropterus salmoides					(1.2)	(1.1-3.6)	(0.0-0.8)
Green sunfish	11	1	1	7	6	33-77	15-93
Lepomis cyanellus	(7.9)	(0.4)	(0.5)	(2.5)	(1.8)	(7.4-14.3)	(3.0-18.3)
Bluegill		1	11	2		2-46	18
Lepomis macrochirus		(0.4)	(5.3)	(0.7)		(0.5-8.6)	(3.5)
Orangespotted sunfish					3	3-5	0-5
Lepomis humilis					(0.9)	(0.6-1.1)	(0.0-1.0)
Longear sunfish				1		0-7	48-99
Lepomis megalotis				(0.4)		(0.0-1.4)	(9.4-19.3)
Pumpkinseed					10	0-1	
Lepomis gibbosus					(3.0)	(0.0-0.1)	
Percidae							
Yellow perch							0-1
Perca flavescens							(0.0-0.1)
Blackside darter						0-1	
Percina maculata						(0.0-0.1)	
Logperch						0-6	
Percina caprodes						(0.0-1.4)	
Johnny darter	5						
Etheostoma nigrum	(3.6)						
Greenside darter	11						
Etheostoma blennioides	(7.9)						
Banded darter	5						
Etheostoma zonale	(3.6)						
Rainbow darter	13			4			
Etheostoma caeruleum	(9.3)			(1.4)			
Orangethroat darter		17					
Etheostoma spectabile		(6.3)					
Fantail darter			3	2			
Etheostoma flabellare			(1.5)	(0.7)			
Total	140	269	205	280	329	446-538	510-513

[a] Values for Dry Lick Run encompass two separate surveys of the same 150-meter section.

TABLE 2

Stream fish community diversity at seven stream and river sites within or near Dayton-Montgomery County Park District reserves. Values for the Stillwater and Great Miami Rivers are ranges from collections made upstream and downstream from the parks.

Diversity index	Twin Creek	Opossum Creek	Dry Lick Run	Sugar Creek	Mad River	Stillwater River	Great Miami River
Number of species	20	8	8	17	19	25-28	23-28
Simpson diversity	0.94	0.60	0.75	0.81	0.85	0.81-0.83	0.74-0.88
Simpson dominance	0.06	0.40	0.25	0.19	0.15	0.17-0.19	0.12-0.26
Shannon diversity	3.98	1.81	2.21	2.86	3.25	3.10-3.38	2.90-3.50
Shannon H_{max}	4.25	3.00	3.00	4.09	4.25	4.64-4.81	4.52-4.81

TABLE 3

Index of Biotic Integrity scoring for each of the 12 metrics used in determining stream quality at the seven Dayton-Montgomery County Park District stream and river sites. Actual metric values are in parentheses. Metrics differ slightly for different streams because of their different drainage areas. Values for the Stillwater and Great Miami Rivers are ranges from collections made upstream and downstream from the parks.

IBI metric	Twin Creek	Opossum Creek	Dry Lick Run	Sugar Creek	Mad River	Stillwater River	Great Miami River
1. Total number of species	3 (19)	5 (8)	3 (8)	5 (17)	3 (19)	5 (25-28)	5 (23-28)
2. Number of darter species Percent round-bodied suckers	3 (4)	3 (1)	1 (1)	1 (2)	3 (36)	5 (49-61)	3-5 (23-56)
3. Number of headwater species Number of sunfish species	1 (1)	3 (2)	3 (3)	3 (2)	5 (4)	5 (5-8)	5 (5-7)
4. Number of minnow species Number of sucker species	3 (4)	3 (4)	5 (5)	6 (3)	3 (4)	5 (8)	5 (7)
5. Number of sensitive species Number of intolerant species	1 (2)	1 (0)	1 (0)	5 (6)	3 (2)	3-5 (3-4)	1-3 (1-2)
6. Percent abundance of tolerant species	5 (15)	5 (33)	5 (28)	1 (72)	1 (36)	1-3 (25-28)	1-5 (14-38)
7. Percent omnivores	5 (6.8)	5 (7)	5 (1)	3 (24)	1 (55)	3-5 (14-21)	5 (14)
8. Percent insectivores	5 (74)	1 (7)	1 (7)	1 (13)	1 (25)	5 (74-75)	5 (73-76)
9. Percent pioneering species Percent top carnivores	5 (12)	5 (24)	5 (20)	3 (43)	5 (13)	1-3 (4-9)	1-3 (3-10)
10. Number of individuals per 300 m Number of individuals per km	3 (294)	5 (538)	3 (205)	3 (560)	3 (329)	5 (446-538)	5 (511-513)
11. Number of simple lithophilic species Percent as simple lithophilic spawners	5 (39)	5 (4)	3 (2)	5 (7)	3 (43)	5 (49-62)	3-5 (20-58)
12. Percent of individuals with deformities, eroded fins, lesions, and tumors	5 (0)	5 (0.4)	5 (0)	5 (0.4)	3 (?)	3 (?)	3 (?)
Total IBI score	44	46	40	38	34	48-52	42-52
Rating	Good	Good	Good	Fair	Fair	Good/ Exceptional	Good/ Exceptional

Outfalls from wastewater treatment facilities can degrade the biological integrity of receiving streams by altering the trophic composition of the entire aquatic community (Karr et al. 1985, Ohio EPA 1987), resulting in a lowered IBI score (Karr et al. 1986, Leonard and Orth 1986). The substandard IBI score (34) for the Mad River site also may have resulted from its location a few kilometers downstream from the Fairborn wastewater treatment plant. However, any possible negative effects of the plant on fish communities apparently do not extend very far downriver, as a site 7.5 kilometers downstream from Huffman Reserve had an IBI score of 49 and a good/exceptional rating (Ohio EPA 1987).

This study indicates that stream fish communities within or near Dayton-Montgomery County Park District reserves generally are healthy. Although IBI scores indicate that water quality and fish communities in reserve streams could be improved, such improvement likely would occur only following drainage-wide improvements in land use (Karr and Schlosser 1978, Scott et al. 1986, Steedman 1988). Even extensive watershed management programs, however, may not improve the biotic integrity of receiving streams (Karr et al. 1987). Attempts at improving fish communities only within reserve sections of streams probably would meet with limited, if any, success.

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